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(54) Dynamic frequency selection in a wireless LAN with channel swapping between access points

Dynamische Frequenzwahl in einem drahtlosen lokalen Netz mit Kanaltausch zwischen Zugriffspunkten

Allocation dynamique de fréquence dans un réseau local sans fil avec échange de canal entre points d'accès

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(73) Proprietor: **Agere Systems Guardian Corporation
Orlando, Florida 32819 (US)**

(72) Inventors:
- **Busch, Patrick
7511 DP Enschede (NL)**
- **Malhorta, Richa
7511 DG Enschede (NL)**

(74) Representative: **Williams, David John et al
Page White & Farrer,
54 Doughty Street
London WC1N 2LS (GB)**

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Description

Field of the invention

[0001] The present invention relates to a communication system comprising a plurality of access points (APs) and network stations, each said network station being arranged to communicate with one of said access points through a wireless communication protocol. The invention also relates to access points for such a communication system.

Background

[0002] Wireless local area networks (LANs) have been developed as an enhanced replacement for wired LANs. In a wireless LAN for data-communication a plurality of (mobile) network stations (e.g., personal computers, telecommunication devices, etc.) are present that are capable of wireless communication. As compared to wired LANs, data-communication in a wireless LAN can be more versatile, due to the flexibility of the arrangement of network stations in the area covered by the LAN, and due to the absence of cabling connections.

[0003] Wireless LANs are generally implemented according to the standard as defined by the ISO/IEC 8802-11 international standard (IEEE 802.11). IEEE 802.11 describes a standard for wireless LAN systems that will operate in the 2.4 - 2.5 GHz ISM (industrial, scientific and medical) band. This ISM band is available worldwide and allows unlicensed operation for spread spectrum systems. For both the US and Europe, the 2,400 - 2,483.5 MHz band has been allocated, while for some other countries, such as Japan, another part of the 2.4 - 2.5 GHz ISM band has been assigned. The IEEE 802.11 standard focuses on the MAC (medium access control) and PHY (physical layer) protocols for AP based networks and ad-hoc networks.

[0004] In AP based wireless networks, the stations within a group or cell can communicate only directly to the AP. This AP forwards messages to the destination station within the same cell or through the wired distribution system to another AP, from which such messages arrive finally at the destination station. In ad-hoc networks, the stations operate on a peer-to-peer level and there is no AP or (wired) distribution system

[0005] The 802.11 standard supports three PHY protocols: DSSS (direct sequence spread spectrum), FHSS (frequency hopping spread spectrum), and infrared with PPM (pulse position modulation). All these three PHYs provide bit rates of 1 and 2 Mbit/s. Furthermore, IEEE 802.11 includes extensions 11a and 11b which allow for additional higher bit rates: Extension 11b provides bit rates 5.5 and 11 Mbit/s as well as the basic DSSS bit rates of 1 and 2 Mbit/s within the same 2.4 - 2.5 GHz ISM band. Extension 11a provides a high bit rate OFDM (Orthogonal Frequency Division Multiplexing modulation) PHY standard providing bit rates in the range of 6 to 54 Mbit/s in the 5 GHz band.

[0006] The IEEE 802.11 basic MAC protocol allows interoperability between compatible PHYs through the use of the CSMA/CA (carrier sense multiple access with collision avoidance) protocol and a random back-off time following a busy medium condition. The IEEE 802.11 CSMA/CA protocol is designed to reduce the collision probability between multiple stations accessing the medium at the same time. Therefore, a random back-off arrangement is used to resolve medium contention conflicts. In addition, the IEEE 802.11 MAC protocol defines special functional behaviour for fragmentation of packets, medium reservation via RTS/CTS (request-to-send/clear-to-send) polling interaction and point co-ordination (for time-bounded services).

[0007] Moreover, the IEEE 802.11 MAC protocol defines Beacon frames sent at regular intervals by the AP to allow stations to monitor the presence of the AP. The IEEE 802.11 MAC protocol also gives a set of management frames including Probe Request frames which are sent by a station and are followed by Probe Response frames sent by an available AP. This protocol allows a station to actively scan for APs operating on other frequency channels and for the APs to show to the stations what parameter settings the APs are using.

[0008] Every DSSS AP operates on one channel. The number of channels depends on the regulatory domain in which the wireless LAN is used (e.g. 11 channels in the US in the 2.4 GHz band). This number can be found in ISO/IEC 8802-11, ANSI/IEEE Std 802.11 Edition 1999-00-00. Overlapping cells using different channels can operate simultaneously without interference if the channel distance is at least 3. Nonoverlapping cells can always use the same channels simultaneously without interference. Channel assignment can be dynamic or fixed. Dynamic channel assignment is preferable, as the environment itself is dynamic as well.

Prior Art

[0009] U.S. patent 5,933,420 discloses a way of assigning channels in a wireless local area network to reduce interference between APs through the APs transmitting messages and reply messages to each other and finding better channel assignments based on the interference information thus obtained. In [**Kamerman, Dec 1999**, published later as EP-A-1 257 093 (Agere Systems Guardian Corporation) 13 November 2002] dynamic assignment of channels is called dynamic frequency selection (DFS). The aim of the DFS algorithm is to dynamically assign channels in a wireless LAN in such a way that the best performance is achieved. Performance can be expressed in terms of throughput, delay and fairness. An AP with dynamic frequency selection is able to switch its channel in order to obtain a better operating channel. It will usually choose a channel with less interference and channel sharing than that on the current channel.

[0010] In the algorithm of **[Kamerman, *Dec* 1999],** the amount of interference an AP is experiencing on a certain channel X, is expressed by a parameter I(X). Channel sharing is expressed by a parameter CS(X). The values of CS(X) and I(X) are combined to calculate a so-called Channel Sharing and Interference Quality CSIQ(X). The value of CSIQ(X) is a measure for the amount of interference and channel sharing belonging to a certain channel X.

[0011] In **[Kamerman, Dec 1999],** an AP will switch to a channel Y if the value of CSIQ(Y) is the highest of all the values CSIQ(X) of the channels X=1,..N with N the number of available channels. So the best channel quality is represented by the highest CSIQ(X). The functioning of the DFS algorithm in **[Kamerman, Dec 1999],** will be explained in an example with help of figure 1a and 1b The wireless LAN 1, shown in figure 1a, comprises a number of access points of which three access points AP1, AP2, AP3 are shown. These access points serve as access point for their respective cells 3, 5, 7 which are each schematically depicted by a circle around their respective access point. In the initial situation, the access points AP1, AP2, AP3 are communicating with their network stations on channels C1, C2, C3, respectively. The cells 3, 5, 7 may have different sizes. Cell size is depending on the desired coverage area of an access point and on the requirements of data throughput in the cell. The cell size can be controlled by suitable setting of the levels of the defer behaviour threshold and carrier sense detection threshold as known from EP-A-0903891. For example, a cell may comprise a number of network stations NS1, NS2 that require high throughputs. In that case, the cell size should be small such that other network stations will be left out of the cell as much as possible. In another case, for example, in a cell only few network stations with low throughput requirements will be present. Then, a single large cell comprising these network stations will be sufficient to handle all data traffic related to that cell. Figure 1a shows the initial situation of a wireless LAN 1 comprising three DFS-capable APs. In the LAN 1 a plurality of network stations NS1, NS2 is present of which only two are shown. In Figure 1 a, for example, the network station NS I is communicating with the access point AP I for all its data traffic. The network station NS1 itself continuously monitors the communication quality (i.e. the difference between signal reception level and average noise level) of its communication with the access point AP1. As long as a good communication quality for the associated access point AP1 is maintained, the network station NS 1 stays communicating with AP1. When the communication quality decreases below a predetermined level, the network station NS1 starts to search for another cell 5 (an access point AP2) with a better communication quality. To this purpose, the network station NS1 is probing the associated access point AP1 and all other access points (i.e. AP2) within range, as known to persons skilled in the art. In this procedure the network station NS 1 uses the signal reception level of Beacon frames received from the associated access point AP1 and Probe Response frames from the other access point AP2. The Probe Response frames are received by the network station NS 1 following Probe Request frames sent by the network station NS1. As known from IEEE 802.11, the other access point AP2 will be operating on a channel with another frequency than the one of access point AP1. Network station NS2, shown in figure 1a, is communicating with AP2. When the communication quality decreases, this network station NS2 also will start to search for another cell with a better communication quality but will not be able to find a better AP so network station NS2 will stay communicating with AP2.

[0012] Figure 1b shows the situation where a non-DFS access point AP4 using, for example channel 9, has arrived within the range of the DFS-capable AP1. With the DFS algorithm of **[Kamerman, Dec 1999],** access point AP1, operating on channel 10, will switch to channel 4 or to channel 11 in order to have at least a channel distance of 2 with every neighbouring cell.

[0013] A problem of the DFS algorithm described in **[Kamerman, Dec 1999]** is the inability to optimise the overall performance. All APs in a wireless LAN will currently optimise their own performance and will not take performance of other APs into consideration. It may well be that, from a network point of view, the division of the channels over the different APs is not optimal. Therefore, it is an object of the present invention to overcome the problem of sub-optimal channel selection.

Summary of the invention

[0014] The present invention relates to an access point (AP1, AP2, AP3) for a wireless LAN communication network, comprising:

- monitor means for monitoring the access point traffic load of the communication network;
- sending means for sending probe requests and probe responses to other access points;
- receiving means for receiving probe requests and probe responses from other access points, including information on said traffic load in said probe responses;
- calculating means for calculating an interference parameter for each of a plurality of its possible channels;
- storage means for storing said calculated interference parameter;
- calculating means for calculating a channel sharing parameter for each of said plurality of channels;
- storage means for storing said calculated channel sharing parameter;
- calculating means for calculating a regular channel quality parameter (regCSIQ) for each of said plurality of channels, indicative of the amount of interference and channel sharing on each of said plurality

of channels, using said interference and channel sharing parameters;
selecting means for dynamically selecting an optimum channel from said plurality of possible channels using said regular channel quality parameters (regCSIQ),

characterized in that said access point further comprises selecting means for selecting said optimum channel by mutually swapping channels with another access point using a swapping mechanism.

[0015] By introducing a swapping option between adjacent assess points, the present invention provides a better overall performance for the wireless LAN.
Moreover, the present invention relates to a wireless LAN communication network, comprising at least two access points as described above.

[0016] Furthermore, the present invention relates to a method of selecting an optimum channel by an access point in a wireless LAN communication network, comprising the steps of:

monitoring its access point traffic load;
sending probe requests and probe responses from other access points;
receiving probe requests and probe responses from other access points;
including information on said traffic load in said probe responses;
calculating an interference parameter for each of a plurality of its possible channels;
storing said calculated interference parameter;
calculating a channel sharing parameter for each of said plurality of channels;
storing said calculated channel sharing parameter;
calculating a regular channel quality parameter (regCSIQ) for each of said plurality of channels, indicative of the amount of interference and channel sharing on each of said plurality of channels, using said interference and channel sharing parameters;
dynamically selecting an optimum channel from said plurality of possible channels using said regular channel quality parameters (regCSIQ),

characterised in that said access point is arranged to select from said optimum channel by mutually swapping channels with another access point using a swapping mechanism.

[0017] The present invention also relates to a computer program product to be loaded by an access point for a wireless LAN communication network, the computer program product providing the access point with the capacity to:

monitor its access point traffic load;
send probe requests and probe responses to other access points;
receive probe requests and probe responses from other access points;
include information on the traffic load in the probe responses;
calculate and store an interference parameter for each of a plurality of its possible channels;
calculate and store a channel sharing parameter for each of the plurality of channels;
calculate a regular channel quality parameter for each of the plurality of channels, indicative of the amount of interference and channel sharing on each of the plurality of channels, using said interference and channel sharing parameters;
dynamically select an optimum channel from the plurality of possible channels using the regular channel quality parameters,

characterised in that the access point is arranged to select from said optimum channel by mutually swapping channels with another access point using a swapping mechanism.

[0018] Moreover, the present invention relates to a computer program product according to claim 14 comprising a data carrier.

Brief description of the drawings

[0019] Below, the invention will be explained with reference to some drawings, which are intended for illustration purposes only and not to limit the scope of protection as defined in the accompanying claims.

Fig. 1a shows the cells of three APs in a wireless LAN in the Prior Art.
Fig. 1b shows the cells of four APs in a wireless LAN in the Prior Art.
Fig. 1c shows the cells of four APs in a wireless LAN as described in the invention.
Fig. 2 shows a block diagram of the arrangement of the present invention for a wireless LAN interface card.
Fig. 3 shows a schematic block diagram of a network station in the present invention.
Fig. 4 shows a schematic block diagram of an access point (AP) in the present invention.
Fig. 5 shows a flow diagram of the swapping procedure of a requesting AP in the present invention.
Fig. 6 shows a flow diagram of the swapping procedure of a responding AP in the present invention.

Description of preferred embodiments

[0020] In figure 1c a schematic overview of a preferred embodiment is shown. A wireless LAN 1 comprises a set of access points AP1, AP2, AP3 which have overlapping cells 3, 5, 7. In this way (mobile) network stations are able to communicate with an AP in a continuous area. Besides LAN 1 a fourth access point AP4 is present having an accompanying cell 9. As in the sit-

uation described in the section Prior Art and figure 1b, it is assumed that AP4 is a non-DFS AP. However, it should be understood that AP4 may be any kind of radio source acting on channel C4. The circles 43 and 45 depict the positions in which the receive level equals the lowest possible carrier detect threshold of respectively AP 1 and AP2.

[0021] Figure 2 shows an example of a block diagram of an arrangement of the present invention for a medium access controller (MAC) device 11 on a wireless LAN interface card 30 installed in network station NS1, NS2 or on a similar wireless LAN interface card 130 installed in access point AP1, AP2, respectively.

[0022] Here, the MAC device 11 is schematically depicted, showing only a signal-processing unit 12, a signal reception level detection circuit 13, an antenna 31 and an on-board memory 14 as needed for the description of this embodiment of the invention. The MAC device 11 may comprise other components not shown here. Also, the components 12, 13, 14 which are shown, may be separate devices or integrated into one device. As desired, the devices also may be implemented in the form of analog or digital circuits. The on-board memory 14 may comprise RAM, ROM, FlashROM and/or other types of memory devices, as are known in the art.

[0023] Figure 3 shows a schematic block diagram of an embodiment of a network station NS1, NS2 comprising processor means 21 with peripherals. The processor means 21 is connected to memory units 18, 22, 23, 24 which store instructions and data, one or more reading units 25 (to read, e.g., floppy disks 19, CD ROM's 20, DVD's, etc.), a keyboard 26 and a mouse 27 as input devices, and as output devices, a monitor 28 and a printer 29. Other input devices, like a trackball and a touch screen, and output devices may be provided for. For data-communication over the wireless LAN 1, an interface card 30 is provided. The interface card 30 connects to an antenna 31.

[0024] The memory units shown comprise RAM 22, (E)EPROM 23, ROM 24 and hard disk 18. However, it should be understood that there may be provided more and/or other memory units known to persons skilled in the art. Moreover, one or more of them may be physically located remote from the processor means 21, if required. The processor means 21 are shown as one box, however, they may comprise several processing units functioning in parallel or controlled by one main processor, that may be located remote from one another, as is known to persons skilled in the art.

[0025] In an alternative embodiment of the present invention, the network station NS1, NS2 may be a telecommunication device in which the components of interface card 30 are incorporated as known to those skilled in the art.

[0026] Figure 4 shows a schematic block diagram of an embodiment of an access point AP1, AP2, AP3 comprising processor means 121 with peripherals. The processor means 121 are connected to memory units 118, 122, 123, 124 which store instructions and data, one or more reading units 125 (to read, e.g., floppy disks 119, CD ROM's 120, DVD's, etc.), a keyboard 126 and a mouse 127 as input devices, and as output devices, a monitor 128 and a printer 129. For data-communication over the wireless LAN 1, an interface card 130 is provided. The interface card 130 connects to an antenna 131. Furthermore, the access point AP1, AP2, AP3 is connected to a wired distribution network 140 through I/O means 132 for communication with, e.g., other access points. The memory units shown comprise RAM 122, (E)EPROM 123, ROM 124 and hard disk 118. However, it should be understood that there may be provided more and/or other memory units known to persons skilled in the art. Moreover, one or more of them may be physically located remote from the processor means 121, if required. The processor means 121 are shown as one box, however, they may comprise several processing units functioning in parallel or controlled by one main processor, that may be located remote from one another, as is known to persons skilled in the art. Moreover, other input/output devices than those shown (i.e. 126, 127, 128, 129) may be provided.

[0027] In an alternative embodiment of the present invention, the access point AP1, AP2, AP3 may be a telecommunication device in which the components of interface card 130 are incorporated as known to those skilled in the art.

[0028] The appearance of a new access point AP4 shown in figure 1c will cause sudden interference to AP1 because it is using channel C4=9 which has a channel distance less than 2 to the channel C1=10 of AP1. Now, in accordance with the invention, access point AP1 decides to start a swapping procedure.

[0029] Figure 5 shows a flow diagram of the swapping procedure for the requesting access point AP1. In the procedure of figure 5 the following parameters are used:

regCSIQ — this is a quality parameter calculated for every possible channel on which the AP can operate; its value is a measure for both channel sharing <u>and</u> interference for the channel concerned. The formula is given by:

$$\mathrm{regCSIQ}(X) = \mathrm{CS}(X) + \mathrm{CorFac} \times \mathrm{I}(X)$$

In contrast with the CSIQ in **[Kamerman, Dec 1999],** the lower the value for regCSIQ(X), the better the channel X. The formulas for CS(X) and I(X) are found in **[Kamerman, Dec 1999];** the parameter CorFac is a correction factor that is preferably equal to 1.

ssCSIQ — swap specific CSIQ; this is a specially calculated quality parameter. The formula is given by:

$$ssCSIQ(X) = regCSIQ'(X) + SwapPenalty$$

where regCSIQ'(X) is calculated in the same way as regCSIQ(X) but under the assumption that a responding AP already uses the channel of a requesting AP, i.e., a situation is assumed in which swapping has already occurred. The SwapPenalty is a parameter indicating that swapping is associated with a certain penalty. It may be zero but preferably it has a positive value, e.g. 10.

[0030] At the start of the swapping procedure, access point AP1 is using channel C1=10. At step 51 the requesting access point AP1 collects interference and sharing information by means of sending Probe Requests to other APs. Then at step 52, AP1 calculates the regCSIQ values for all possible channels. At step 53, AP1 calculates a swap specific

[0031] CSIQ (ssCSIQ) for every channel used by any AP responding to the Probe Request. For the calculation of the swap specific CSIQ values, the formula for regCSIQ is used, but with the assumption that the responding access points AP2, AP3 are not using the channel on which they are actually operating, but the channel on which the requesting AP is operating.

[0032] The swap specific CSIQ value is increased by a certain amount, (e.g., by 10). A swap should not be executed when it is not necessary, because of possible overhead costs. By increasing the ssCSIQ by e.g. 10, it becomes more likely that a channel with a regular CSIQ is selected for switching and swapping is not necessary.

[0033] Now at step 55, the lowest CSIQ is determined out off all the calculated regCSIQ values and all the ssCSIQ values. If the lowest ssCSIQ is smaller than the lowest regCSIQ the procedure will go on to step 57. If this is not the case step 69 will be executed. At step 57, AP1 calculates the difference between the lowest regCSIQ and the lowest ssCSIQ. This difference, named $SwapBinP_{AP1}$, is the benefit in performance for AP1 if AP1 would swap channels (with the AP corresponding to the lowest ssCSIQ) instead of switching its channel to the channel corresponding to the lowest regCSIQ. At step 59, a Swap Request is sent using the channel corresponding to the lowest ssCSIQ value. The swap request contains the channel C1 of AP1 requesting the swap, and it also contains the value for $SwapBinP_{AP1}$.

[0034] Now at step 61, the access point AP1 will wait for a Swap Response during a predefined time period T_wait. If AP1 has received a Swap Response within T_wait ms, the result of step 63 is YES and step 65 follows. If the result of the test at step 63 is NO, then the next step will be step 69 and the channel will be switched to a channel C5, corresponding to the lowest regCSIQ.

[0035] At step 65, the Swap Response is checked. If the Swap Response is 'yes', then step 67 follows. This means that AP1 will change its channel to the value of the one of the responding access point AP2 (i.e., C2). If at step 65 the Swap Response is 'no', step 69 will be executed and AP1 will switch to said channel C5.

[0036] Figure 6 shows a flow diagram of the swapping procedure for the responding access point AP2. At the start of the procedure, access point AP2 is using channel C2=6. At step 75, access point AP2 is operating normally and is stand-by for any Swap Request. If, at step 77, a request is received, AP2 will proceed to step 79. If no Swap Request is received AP2 will stay at step 75. At step 79, the access point AP2 will rescan all the channels in order to get the Probe Responses of neighbouring APs. During the scan of a channel X, AP2 switches to the channel in question (i.e. X) and configures itself temporarily to the lowest defer threshold and bit rate to allow communication over as large as possible distance, see circle 45 in figure 1c. AP2 sends a Probe Request frame to evoke a Probe Response from all APs tuned to the channel in question and within radio range. The Probe Response packets sent by the APs responding to the Probe Request, carry information on load factors from each AP using the channel in question. The gathered load information from all the probe responding APs together with the receive levels of the Probe Responses, is stored by AP2. This is done for all the channels and in the same way as in **[Kamerman, Dec 1999]**.

[0037] Next, at step 80, the regCSIQ value for the operating channel of AP2 is calculated. This means regCSIQ(C2) is calculated.At step 81, the value of ssCSIQ is calculated for the channel that is used by the swap requesting AP1. This means ssCSIQ(C1) is calculated using the load and receive level information stored by AP2 at step 79. Then at step 83, access point AP2 switches its channel to the one of the swap requesting AP1 (i.e., C1). At step 85, the value of ssCSIQ(C1) is compared to the value of regCSIQ(C2). If ssCSIQ(C1) is lower than regCSIQ(C2), then access point AP2 will send a Swap Response 'yes' at step 87. If ssCSIQ(C1) is <u>not</u> lower than regCSIQ(C2) the procedure will go to step 88. In step 88 the administrative domain (e.g. company or organisation) of AP1 is compared with the one of AP2. If the domains are not the same, step 90 is executed. If the two domains match, then step 89 will follow in which another, so-called 'sacrifice' test is done. At this step the benefit in performance for, and predicted by, requesting AP1 (i.e., $SwapBinP_{AP1}$) is compared to the predicted decrease in performance for AP2 (i.e., ssCSIQ(C1)-regCSIQ(C2)). If the benefit in performance for AP1 is higher than the decrease in performance for AP2, access point AP2 will sacrifice its channel and will agree to swap channels. This means that step 87 will follow. If the answer to the test in step 88 is NO, then step 90 follows. This means that AP2 will send a Swap Response 'no' to the swap requesting AP1. After this, AP2 will switch its channel back to C2=6, see step 91.

[0038] The swapping procedure described above is not a low-overhead solution. Therefore, it should not be

attempted frequently. It should only be attempted once per channel change. Once a swap has failed for a certain AP, it should not be attempted in the near future. Therefore, the information record that exists for every DFS-capable AP, also contains a timer. This timer is used to ensure that swap requests to the same AP are separated by a certain number of hours (i.e., 24).

Claims

1. An access point (AP1, AP2, AP3) for a wireless LAN communication network, comprising:

   monitor means for monitoring the access point traffic load of the communication network;
   sending means for sending probe requests and probe responses to other access points;
   receiving means for receiving probe requests and probe responses from other access points, including information on said traffic load in said probe responses;
   calculating means for calculating an interference parameter for each of a plurality of its possible channels;
   storage means for storing said calculated interference parameter;
   calculating means for calculating a channel sharing parameter for each of said plurality of channels;
   storage means for storing said calculated channel sharing parameter;
   calculating means for calculating a regular channel quality parameter (regCSIQ) for each of said plurality of channels, indicative of the amount of interference and channel sharing on each of said plurality of channels, using said interference and channel sharing parameters;
   selecting means for dynamically selecting an optimum channel from said plurality of possible channels using said regular channel quality parameters (regCSIQ),

   characterized in that said access point further comprises selecting means for selecting said optimum channel by mutually swapping channels with another access point using a swapping mechanism.

2. An access point according to claim 1, wherein said access point is a swap requesting access point (AP1), operating on a first channel (C1),the access point further comprising means for calculating and storing a swap specific channel quality parameter (ssCSIQ) for every responding access point (AP2) operating on a second channel (C2), said swapping specific channel quality parameter (ssCSIQ) being calculated under the assumption that every responding access point (AP2) and said requesting access point (AP1) have already swapped channels, which swapping specific channel quality parameter is used in said swapping mechanism.

3. An access point according to claim 2, wherein said swapping mechanism includes: calculating means for calculating a benefit-in-performance parameter (SwapBinP) having a value equal to a difference between a lowest of all regular channel quality parameters and a lowest of all swap specific channel quality parameters;

   sending means for sending a swap request containing said benefit-in-performance parameter (SwapBinP) to another access point that corresponds to said lowest of all swap specific channel quality parameters of all said responding access points (AP2);
   waiting means for a swap response from said other access point (AP2);
   switching means for switching to a channel corresponding to said lowest of all swap specific channel quality parameters if said swap response is 'yes';
   switching means for switching to a channel corresponding to said lowest of all regular channel quality parameters if said swap response is 'no'.

4. An access point according to claim 1, wherein said access point is a swap responding access point (AP2) comprising: receiving means for receiving a swap request from a swap requesting access point (AP1) operating on a first channel (C1) whereas the swap responding access point is operating on a second channel (C2);

   rescanning means for rescanning all its channels to gather probe responses from other access points;
   switching means for switching from said second (C2) to said first (C1) channel;
   calculating means for calculating a swap specific channel quality parameter (ssCSIQ(C1)) for said first channel (C1), said swap specific channel quality parameter (ssCSIQ(C1)) being calculated assuming that said responding access point (AP2) and said swap requesting access point (AP1) have already swapped channels;
   sending means for sending a swap response "yes" if said swap specific channel quality parameter (ssCSIQ(C1)) for said first channel (C1) is less than a regular channel quality parameter (regCSIQ(C2)) calculated for said second channel (C2).

5. An access point according to claim 4, wherein said access point comprises means for performing the

following steps: receiving a benefit-in-performance parameter (SwapBinP) from said swap requesting access point, having a value equal to a difference between a lowest of all regular channel quality parameters and a lowest of all swap specific channel quality parameters for said swap requesting access point; if no swap response "yes" can be sent, calculating a decrease-in-performance parameter indicating a decrease in performance of said swap responding access point that would occur when it would have swapped channels with said swap requesting access point;

sending a swap response "yes" if said benefit-in-performance parameter (SwapBinP) is larger than said decrease-in-performance parameter.

6. An access point according to any of the claims 1-5, wherein said access point comprises means for using said swapping mechanism only after a predetermined time has lapsed since a last time of using said swapping mechanism.

7. A wireless LAN communication network, comprising at least two access points according to any of the proceeding claims.

8. A method of selecting an optimum channel by an access point in a wireless LAN communication network, comprising the steps of:

monitoring its access point traffic load;
sending probe requests and probe responses from other access points;
receiving probe requests and probe responses from other access points;
including information on said traffic load in said probe responses;
calculating an interference parameter for each of a plurality of its possible channels;
storing said calculated interference parameter;
calculating a channel sharing parameter for each of said plurality of channels;
storing said calculated channel sharing parameter;
calculating a regular channel quality parameter (regCSIQ) for each of said plurality of channels, indicative of the amount of interference and channel sharing on each of said plurality of channels, using said interference and channel sharing parameters;
dynamically selecting an optimum channel from said plurality of possible channels using said regular channel quality parameters (regCSIQ),

characterised in that said access point is arranged to select from said optimum channel by mutually swapping channels with another access point using a swapping mechanism.

9. A method according to claim 8, wherein said method of selecting an optimum channel includes a swap requesting access point (AP1), operating on a first channel (C1),that calculates and stores a swap specific channel quality parameter (ssCSIQ) for every responding access point (AP2) operating on a second channel (C2), said swapping specific channel quality parameter (ssCSIQ) being calculated under the assumption that every responding access point (AP2) and said requesting access point (AP1) have already swapped channels, which swapping specific channel quality parameter is used in said swapping mechanism.

10. A method according to claim 9, wherein said swapping mechanism includes the following steps:

calculating a benefit-in-performance parameter (SwapBinP) having a value equal to a difference between a lowest of all regular channel quality parameters and a lowest of all swap specific channel quality parameters;
sending a swap request containing said benefit-in-performance parameter (SwapBinP) to another access point that corresponds to said lowest of all swap specific channel quality parameters of all said responding access points (AP2);
waiting for a swap response from said other access point (asp2);
switching to a channel corresponding to said lowest of all swap specific channel quality parameters if said swap response is "yes";
switching to a channel corresponding to said lowest of all regular channel quality parameters if said swap response is "no" .

11. A method according to claim 8, wherein said access point is a swap responding access point (AP2), the method of selecting an optimum channel by an access point further including the steps of:

receiving a swap request from a swap requesting access point (AP1) operating on a first channel (C1) whereas the swap responding access point is operating on a second channel (C2);
rescanning all its channels to gather probe responses from other access points;
switching from said second (C2) to said first (C1) channel;
calculating a swap specific channel quality parameter (ssCSIQ(CI)) for said first channel (C1), said swap specific channel quality parameter (ssCSIQ(C1)) being calculated assuming that said responding access point (AP2) and

said swap requesting access point (AP1) have already swapped channels;
sending a swap response "yes" if said swap specific channel quality parameter (ssCSIQ (C1)) for said first channel (C1) is less than a regular channel quality parameter (regCSIQ (C2)) calculated for said second channel (C2).

12. A method according to claim 11, wherein said method further includes performing the following steps:

receiving a benefit-in-performance parameter (SwapBinP) from said swap requesting access point, having a value equal to a difference between a lowest of all regular channel quality parameters and a lowest of all swap specific channel quality parameters for said swap requesting access point;
if no swap response "yes" can be sent, calculating a decrease-in-performance parameter indicating a decrease in performance of said swap responding access point that would occur when it would have swapped channels with said swap requesting access point;
sending a swap response "yes" if said benefit-in-performance parameter (SwapBinP) is larger than said decrease-in-performance parameter.

13. A method according to any of the claims 8 to 12, wherein said access point is arranged to use said swapping mechanism only after a predetermined time has lapsed since a last time of using said swapping mechanism.

14. A computer program product to be loaded by an access point for a wireless LAN communication network, said computer program product providing said access point with the capacity to:

monitor its access point traffic load;
send probe requests and probe responses to other access points;
receive probe requests and probe responses from other access points;
include information on said traffic load in said probe responses;
calculate and store an interference parameter for each of a plurality of its possible channels;
calculate and store a channel sharing parameter for each of said plurality of channels;
calculate a regular channel quality parameter (regCSIQ) for each of said plurality of channels, indicative of the amount of interference and channel sharing on each of said plurality of channels, using said interference and channel sharing parameters;
dynamically select an optimum channel from said plurality of possible channels using said regular channel quality parameters (regCSIQ),

characterised in that said access point is arranged to select said optimum channel by mutually swapping channels with another access point using a swapping mechanism.

15. A computer program product according to claim 14 comprising a data carrier.

Patentansprüche

1. Zugriffspunkt (AP1, AP2, AP3) für ein drahtloses LAN-Kommunikationsnetz, der umfasst:

Überwachungsmittel zum Überwachen der Zugriffspunkt-Verkehrslast des Kommunikationsnetzes;
Sendemittel zum Senden von Prüfanforderungen und Prüfantworten an andere Zugriffspunkte;
Empfangsmittel zum Empfangen von Prüfanforderungen und Prüfantworten von anderen Zugriffspunkten, die Informationen über die Verkehrslast in den Prüfantworten enthalten;
Berechnungsmittel zum Berechnen eines Parameters der gegenseitigen Störung für jeden von mehreren seiner möglichen Kanäle;
Speichermittel zum Speichern der berechneten Parameter der gegenseitigen Störung;
Berechnungsmittel zum Berechnen eines Parameters der gemeinsamen Kanalnutzung für jeden der mehreren Kanäle;
Speichermittel zum Speichern des berechneten Parameters der gemeinsamen Kanalnutzung;
Berechnungsmittel zum Berechnen eines Parameters (regCSIQ) der regulären Kanalqualität für jeden der mehreren Kanäle, der den Grad der gegenseitigen Störung und der gemeinsamen Kanalnutzung für jeden der mehreren Kanäle unter Verwendung der Parameter der gegenseitigen Störung bzw. der gemeinsamen Kanalnutzung angibt;
Auswahlmittel zum dynamischen Auswählen eines optimalen Kanals aus den mehreren möglichen Kanälen unter Verwendung der Parameter (regCSIQ) der regulären Kanalqualität,

dadurch gekennzeichnet, dass der Zugriffspunkt ferner Auswahlmittel umfasst, die den optimalen Kanal durch gegenseitiges Austauschen von Kanälen mit einem weiteren Zugriffspunkt unter Verwendung eines Austauschmechanismus auswählen.

2. Zugriffspunkt nach Anspruch 1, wobei der Zugriffspunkt ein einen Austausch anfordernder Zugriffspunkt (AP1) ist, der auf einem ersten Kanal (C1) arbeitet, wobei der Zugriffspunkt ferner Mittel umfasst, die einen Parameter (ssCSIQ) der austauschspezifischen Kanalqualität für jeden antwortenden Zugriffspunkt (AP2), der auf einem zweiten Kanal (C2) arbeitet, berechnen und speichern, wobei der Parameter (ssCSIQ) der austauschspezifischen Kanalqualität unter der Annahme berechnet wird, dass jeder antwortende Zugriffspunkt (AP2) und der anfordernde Zugriffspunkt (AP1) bereits Kanäle ausgetauscht haben, deren Parameter der austauschspezifischen Kanalqualität in dem Austauschmechanismus verwendet wird.

3. Zugriffspunkt nach Anspruch 2, bei dem der Austauschmechanismus umfasst:

   Berechnungsmittel zum Berechnen eines Leistungsnutzen-Parameters (SwapBinP), der einen Wert hat, der gleich einer Differenz zwischen einem niedrigsten aller Parameter der regulären Kanalqualität und einem niedrigsten aller Parameter einer austauschspezifischen Kanalqualität ist;
   Sendemittel zum Senden einer Austauschanforderung, die den Leistungsnutzen-Parameter (SwapBinP) enthält, an einen weiteren Zugriffspunkt, der dem niedrigsten aller Parameter der austauschspezifischen Kanalqualität aller antwortenden Zugriffspunkte (AP2) entspricht;
   Mittel, die auf eine Austauschantwort von dem anderen Zugriffspunkt (AP2) warten;
   Umschaltmittel zum Umschalten zu einem Kanal, der dem niedrigsten aller Parameter der austauschspezifischen Kanalqualität entspricht, falls die Austauschantwort "ja" ist;
   Umschaltmittel zum Umschalten zu einem Kanal, der dem niedrigsten aller Parameter der regulären Kanalqualität entspricht, falls die Austauschantwort "nein" ist.

4. Zugriffspunkt nach Anspruch 1, wobei der Zugriffspunkt ein auf einen Austausch antwortender Zugriffspunkt (AP2) ist und umfasst:

   Empfangsmittel zum Empfangen einer Austauschanforderung von einem einen Austausch anfordernden Zugriffspunkt (AP1), der auf einem ersten Kanal (C1) arbeitet, während der auf einen Austaush antwortend Zugriffpunkt auf einem zweiten Kanal (C2) arbeitet;
   Neuabtastmittel zum erneuten Abtasten aller seiner Kanäle, um Prüfantworten von anderen Zugriffspunkten zu sammeln;
   Umschaltmittel zum Umschalten von dem zweiten Kanal (C2) zu dem ersten Kanal (C1);
   Berechnungsmittel zum Berechnen eines Parameters (ssCSIQ(C1)) der austauschspezifischen Kanalqualität für den ersten Kanal (C1), wobei der Parameter (ssCSIQ(C1)) der austauschspezifischen Kanalqualität unter der Annahme berechnet wird, dass der antwortende Zugriffspunkt (AP2) und der einen Austausch anfordernde Zugriffspunkt (AP1) bereits Kanäle ausgetauscht haben;
   Sendemittel zum Senden einer Austauschantwort "ja", falls der Parameter (ssCSIQ(C1)) der austauschspezifischen Kanalqualität für den ersten Kanal (C1) kleiner als ein für den zweiten Kanal (C2) berechneter Parameter (regCSIQ (C2)) der regulären Kanalqualität ist.

5. Zugriffspunkt nach Anspruch 4, wobei der Zugriffspunkt Mittel umfasst, die die folgenden Schritte ausführen:

   Empfangen eines Leistungsnutzen-Parameters (SwapBinP) von dem einen Austausch anfordernden Zugriffspunkt, der einen Wert hat, der gleich einer Differenz zwischen einem niedrigsten aller Parameter der regulären Kanalqualität und einem niedrigsten aller Parameter der austauschspezifischen Kanalqualität für den einen Austausch anfordernden Zugriffspunkt ist;
   falls keine Austauschantwort "ja" gesendet werden kann, Berechnen eines Leistungsabnahmeparameters, der eine Abnahme der Leistung des auf einen Austausch antwortenden Zugriffspunkts angibt, die auftreten würde, wenn er mit dem einen Austausch anfordernden Zugriffspunkt Kanäle ausgetauscht hätte;
   Senden einer Austauschantwort "ja", falls der Leistungsnutzen-Parameter (SwapBinP) größer als der Leistungsabnahme-Parameter ist.

6. Zugriffspunkt nach einem der Ansprüche 1-5, wobei der Zugriffspunkt Mittel umfasst, die den Austauschmechanismus nur dann verwenden, wenn eine vorgegebene Zeit seit einer letzten Verwendung des Austauschmechanismus verstrichen ist.

7. Drahtloses LAN-Kommsunikationsnet, das wenigstens zwei Zugriffspunkte nach einem der vorhergehenden Ansprüche enthält.

8. Verfahren zum Auswählen eines optimalen Kanals durch einen Zugriffspunkt in einem drahtlosen LAN-Kommunikationsnetz, das die folgenden Schritte umfasst:

   Überwachen seiner Zugriffspunkt-Verkehrslast;
   Senden von Prüfanforderungen und von

Prüfantworten von anderen Zugriffspunkten;
Empfangen von Prüfanforderungen und von Prüfantworten von anderen Zugriffspunkten;
Aufnehmen von Informationen über die Verkehrslast in die Prüfantworten;
Berechnen eines Parameters der gegenseitigen Störung für jeden von mehreren seiner möglichen Kanäle;
Speichern des berechneten Parameters der gegenseitigen Störung;
Berechnen eines Parameters der gemeinsamen Kanalnutzung für jeden der mehreren Kanäle;
Speichern der berechneten Parameter der gemeinsamen Kanalnutzung;
Berechnen eines Parameters (regCSIQ) der regulären Kanalqualität für jeden der mehreren Kanäle, der den Grad an gegenseitiger Störung und der gemeinsamen Kanalnutzung auf jedem der mehreren Kanäle angibt, unter Verwendung der Parameter der gegenseitigen Störung und der gemeinsamen Kanalnutzung;
dynamisches Auswählen eines optimalen Kanals aus den mehreren möglichen Kanälen unter Verwendung der Parameter (regCSIQ) der regulären Kanalqualität,

dadurch gekennzeichnet, dass der Zugriffspunkt so beschaffen ist, dass er den optimalen Kanal dadurch auswählt, dass er Kanäle mit einem weiteren Zugriffspunkt unter Verwendung eines Austauschmechanismus gegenseitig austauscht.

9. Verfahren nach Anspruch 8, wobei das Verfahren des Auswählens eines optimalen Kanals einen einen Austausch anfordernden Zugriffspunkt (AP1) umfasst, der auf einem ersten Kanal (C1) arbeitet und einen Parameter (ssCSIQ) der austauschspezifischen Kanalqualität für jeden antwortenden Zugriffspunkt (AP2), der auf einem zweiten Kanal (C2) arbeitet, berechnet und speichert, wobei der Parameter (ssCSIQ) der austauschspezifischen Kanalqualität unter der Annahme berechnet wird, dass jeder antwortende Zugriffspunkt (AP2) und der anfordernde Zugriffspunkt (AP1) bereits Kanäle ausgetauscht haben, wobei der Parameter der austauschspezifischen Kanalqualität in dem Austauschmechanismus verwendet wird.

10. Verfahren nach Anspruch 9, bei dem der Austauschmechanismus die folgenden Schritte enthält:

Berechnen eines Leistungsnutzen-Parameters (SwapBinP), der einen Wert hat, der gleich einer Differenz zwischen einem niedrigsten aller Parameter der regulären Kanalqualität und einem niedrigsten aller Parameter der austauschspezifischen Kanalqualität ist;
Senden einer Austauschanforderung, die den Leistungsnutzen-Parameter (SwapBinP) enthält, zu einem weiteren Zugriffspunkt, der dem niedrigsten aller Parameter der austauschspezifischen Kanalqualität unter allen antwortenden Zugriffspunkten (AP2) entspricht;
Warten auf eine Austauschantwort von dem anderen Zugriffspunkt (AP2);
Umschalten zu einem Kanal, der dem niedrigsten aller Parameter der austauschspezifischen Kanalqualität entspricht, falls die Austauschantwort "ja" ist;
Umschalten zu einem Kanal, der dem niedrigsten aller Parameter der regulären Kanalqualität entspricht, falls die Austauschantwort "nein" ist.

11. Verfahren nach Anspruch 8, bei dem der Zugriffspunkt ein auf einen Austausch antwortender Zugriffspunkt (AP2) ist, wobei das Verfahren einen optimalen Kanal durch einen Zugriffspunkt auswählt und ferner die folgenden Schritte umfasst:

Empfangen einer Austauschanforderung von einem einen Austausch anfordernden Zugriffspunkt (AP1), der auf einem ersten Kanal (C1) arbeitet, während der auf den Austausch antwortende Zugriffspunkt auf einem zweiten Kanal (C2) arbeitet;
erneutes Abtasten aller seiner Kanäle, um Prüfantworten von anderen Zugriffspunkten zu sammeln;
Umschalten von dem zweiten Kanal (C2) zu dem ersten Kanal (C1);
Berechnen eines Parameters (ssCSIQ(C1)) der austauschspezifischen Kanalqualität für den ersten Kanal (C1), wobei der Parameter (ssCSIQ(C1)) der austauschspezifischen Kanalqualität unter der Annahme berechnet wird, dass der antwortende Zugriffspunkt (AP2) und der einen Austausch anfordernde Zugriffspunk (AP1) bereits Kanäle ausgetauscht haben;
Senden einer Austauschantwort "ja", falls der Parameter (ssCSIQ(C1)) der austauschspezifischen Kanalqualität für den ersten Kanal (C1) kleiner als der Parameter (regCSIQ(C2)) der regulären Kanalqualität, der für den zweiten Kanal (C2) berechnet wird, ist.

12. Verfahren nach Anspruch 11, wobei das Verfahren ferner die Ausführung der folgenden Schritte umfasst:

Empfangen eines Leistungsnutzen-Parameters (SwapBinP) von dem einen Austausch anfordernden Zugriffspunkt, der einen Wert hat, der gleich einer Differenz zwischen einem niedrigsten aller Parameter der regulären Kanal-

qualität und einem niedrigsten aller Parameter der austauschspezifischen Kanalqualität für den einen Austausch anfordernden Zugriffspunkt ist;
falls keine Austauschantwort "ja" gesendet werden kann, Berechnen eines Leistungsabnahme-Parameters, der eine Abnahme der Leistung des auf einen Austausch antwortenden Zugriffspunkts angibt, die auftreten würde, wenn er mit dem einen Austausch anfordernden Zugriffspunkt Kanäle ausgetauscht hätte;
Senden einer Austauschantwort "ja", falls der Leistungsnutzen-Parameter (SwapBinP) größer als der Leistungsabnahme-Parameter ist.

13. Verfahren nach einem der Ansprüche 8 bis 12, bei dem der Zugriffspunkt so beschaffen ist, dass er den Austauschmechanismus nur verwendet, nachdem eine vorgegebene Zeit seit einer letzten Verwendung des Austauschmechanismus verstrichen ist.

14. Computerprogrammprodukt, das durch einen Zugriffspunkt für ein drahtloses LAN-Kommunikationsnetz zu laden ist, wobei das Computerprogrammprodukt für den Zugriffspunkt die Fähigkeit bereitstellt:

seine Zugriffspunkt-Verkehrslast zu überwachen;
Prüfanforderungen und Prüfantworten an andere Zugriffspunkte zu senden;
Prüfanforderungen und Prüfantworten von anderen Zugriffspunkten zu empfangen;
Informationen über die Verkehrslast in die Prüfantworten einzuschließen;
einen Parameter der gegenseitigen Störung für jeden von mehreren seiner möglichen Kanäle zu berechnen und zu speichern;
einen Parameter der gemeinsamen Kanalnutzung für jeden der mehreren Kanäle zu berechnen und zu speichern;
einen Parameter (regCSIQ) der regulären Kanalqualität für jeden der mehreren Kanäle, der den Grad der gegenseitigen Störung und der gemeinsamen Kanalnutzung auf jedem der mehreren Kanäle angibt, unter Verwendung der Parameter der gegenseitigen Störung und der gemeinsamen Kanalnutzung zu berechnen;
einen optimalen Kanal aus den mehreren möglichen Kanälen unter Verwendung der Parameter (regCSIQ) der regulären Kanalqualität dynamisch auszuwählen,

dadurch gekennzeichnet, dass der Zugriffspunkt so beschaffen ist, dass er den optimalen Kanal dadurch auswählt, dass er mit einem weiteren Zugriffspunkt unter Verwendung eines Austauschmechanismus gegenseitig Kanäle austauscht.

15. Computerprogrammprodukt nach Anspruch 14, das einen Datenträger enthält.

Revendications

1. Point d'accès (AP1, AP2, AP3) pour un réseau de communication consistant en un réseau local sans fil, comprenant :

un moyen de surveillance pour surveiller la charge de trafic du point d'accès du réseau de communication;
un moyen d'envoi pour envoyer des demandes d'investigation et des réponses d'investigation vers d'autres points d'accès;
un moyen de réception pour recevoir des demandes d'investigation et des réponses d'investigation provenant d'autres points d'accès, incluant de l'information sur la charge de trafic dans lesdites réponses d'investigation;
un moyen de calcul pour calculer un paramètre de brouillage pour chacun de la multiplicité de ses canaux possibles;
un moyen de stockage pour stocker le paramètre de brouillage calculé;
un moyen de calcul pour calculer un paramètre de partage de canal pour chacun de la multiplicité de canaux;
un moyen de stockage pour stocker le paramètre de partage de canal calculé;
un moyen de calcul pour calculer un paramètre de qualité de canal normal (regCSIQ) pour chacun de la multiplicité de canaux, indiquant le niveau de brouillage et de partage de canal sur chacun de la multiplicité de canaux, en utilisant les paramètres de brouillage et de partage de canal;
un moyen de sélection pour sélectionner de façon dynamique un canal optimal parmi la multiplicité de canaux possibles en utilisant les paramètres de qualité de canal normaux (regCSIQ),

caractérisé en ce que ce point d'accès comprend en outre un moyen de sélection pour sélectionner le canal optimal en échangeant mutuellement des canaux avec un autre point d'accès, en utilisant un mécanisme d'échange.

2. Point d'accès selon la revendication 1, dans lequel le point d'accès est un point d'accès demandeur d'échange (AP1), fonctionnant sur un premier canal (C1), le point d'accès comprenant en outre un

moyen pour calculer et stocker un paramètre de qualité de canal spécifique à la fonction d'échange (ssCSIQ) pour chaque point d'accès répondeur (AP2), fonctionnant sur un second canal (C2), ce paramètre de qualité de canal spécifique à la fonction d'échange (ssCSIQ) étant calculé dans l'hypothèse selon laquelle chaque point d'accès répondeur (AP2) et le point d'accès demandeur (AP1) ont déjà échangé des canaux, ce paramètre de qualité de canal spécifique à la fonction d'échange étant utilisé dans le mécanisme d'échange.

3. Point d'accès selon la revendication 2, dans lequel le mécanisme d'échange comprend :

un moyen de calcul pour calculer un paramètre de bénéfice en performances (SwapBinP) ayant une valeur égale à une différence entre un plus bas de tous les paramètres de qualité de canal normaux, et un plus bas de tous les paramètres de qualité de canal spécifiques à la fonction d'échange;
un moyen d'envoi pour envoyer une demande d'échange contenant le paramètre de bénéfice en performances (SwapBinP) vers un autre point d'accès qui correspond au plus bas de tous les paramètres de qualité de canal spécifiques à la fonction d'échange, de tous les points d'accès répondeurs (AP2);
un moyen d'attente d'une réponse d'échange provenant dudit autre point d'accès (AP2);
un moyen de commutation pour commuter vers un canal correspondant au plus bas de tous les paramètres de qualité de canal spécifiques à la fonction d'échange, si la réponse d'échange est "oui";
un moyen de commutation pour commuter vers un canal correspondant au plus bas de tous les paramètres de qualité de canal normaux si la réponse d'échange est "non".

4. Point d'accès selon la revendication 1, dans lequel le point d'accès est un point d'accès répondeur d'échange (AP2) comprenant :

un moyen de réception pour recevoir une demande d'échange provenant d'un point d'accès demandeur d'échange (AP1) fonctionnant sur un premier canal (C1), tandis que le point d'accès répondeur d'échange fonctionne sur un second canal (C2);
un moyen de répétition de scrutation pour répéter la scrutation de tous ses canaux de façon à collecter des réponses d'investigation provenant d'autres points d'accès;
un moyen de commutation pour commuter du second canal (C2) vers le premier canal (C1);
un moyen de calcul pour calculer un paramètre de qualité de canal spécifique à la fonction d'échange (ssCSIQ(C1)) pour le premier canal (C1), ce paramètre de qualité de canal spécifique à la fonction d'échange (ssCSIQ(C1)) étant calculé dans l'hypothèse selon laquelle le point d'accès répondeur (AP2) et le point d'accès demandeur d'échange (AP1) ont déjà échangé des canaux;
un moyen d'envoi pour envoyer une réponse d'échange "oui" si le paramètre de qualité de canal spécifique à la fonction d'échange (ssCSIQ(CI)) pour le premier canal (C1) est inférieur à un paramètre de qualité de canal normal (regCSIQ(C2)) calculé pour le second canal (C2).

5. Point d'accès selon la revendication 4, dans lequel ce point d'accès comprend un moyen pour accomplir les étapes suivantes :

recevoir un paramètre de bénéfice en performances (SwapBinP) provenant du point d'accès demandeur d'échange, ayant une valeur égale à une différence entre un plus bas de tous les paramètres de qualité de canal normaux et un plus bas de tous les paramètres de qualité de canal spécifiques à la fonction d'échange, pour le point d'accès demandeur d'échange;
si aucune réponse d'échange "oui" ne peut être envoyée, calculer un paramètre de diminution de performances indiquant une diminution des performances du point d'accès répondeur d'échange qui se produirait lorsqu'il aurait échangé des canaux avec le point d'accès demandeur d'échange;
envoyer une réponse d'échange "oui" si le paramètre de bénéfice en performances (SwapBinP) est plus grand que le paramètre de diminution de performances.

6. Point d'accès selon l'une quelconque des revendications 1-5, dans lequel le point d'accès comprend un moyen pour utiliser le mécanisme d'échange seulement après qu'un temps prédéterminé s'est écoulé depuis une dernière fois que le mécanisme d'échange a été utilisé.

7. Réseau de communication du type réseau local sans fil, comprenant au moins deux points d'accès conformes à l'une quelconque des revendications précédentes.

8. Procédé de sélection d'un canal optimal par un point d'accès dans un réseau de communication du type réseau local sans fil, comprenant les étapes suivantes :

on surveille sa charge de trafic de point d'accès;

on envoie des demandes d'investigation et des réponses d'investigation à partir d'autres points d'accès;
on reçoit des demandes d'investigation et des réponses d'investigation provenant d'autres points d'accès;
on inclut dans les réponses d'investigation une information concernant ladite charge de trafic;
on calcule un paramètre de brouillage pour chacun d'une multiplicité de ses canaux possibles;
on stocke le paramètre de brouillage calculé;
on calcule un paramètre de partage de canal pour chacun de la multiplicité de canaux;
on stocke le paramètre de partage de canal calculé;
on calcule un paramètre de qualité de canal normal (regCSIQ) pour chacun de la multiplicité de canaux, indiquant le niveau de brouillage et de partage de canal sur chacun de la multiplicité de canaux, en utilisant les paramètres de brouillage et de partage de canal;
on sélectionne de façon dynamique un canal optimal parmi la multiplicité de canaux possibles en utilisant les paramètres de qualité de canal normaux (regCSIQ),

caractérisé en ce que le point d'accès est arrangé pour sélectionner le canal optimal en échangeant mutuellement des canaux avec un autre point d'accès, en utilisant un mécanisme d'échange.

9. Procédé selon la revendication 8, dans lequel le procédé de sélection d'un canal optimal comprend un point d'accès demandeur d'échange (AP1), fonctionnant sur un premier canal (C1), qui calcule et stocke un paramètre de qualité de canal spécifique à la fonction d'échange (ssCSIQ) pour chaque point d'accès répondeur (AP2) fonctionnant sur un second canal (C2), ce paramètre de qualité de canal spécifique à la fonction d'échange (ssCSIQ) étant calculé dans l'hypothèse selon laquelle chaque point d'accès répondeur (AP2) et le point d'accès demandeur (AP1) ont déjà échangé des canaux, ce paramètre de qualité de canal spécifique à la fonction d'échange étant utilisé dans le mécanisme d'échange.

10. Procédé selon la revendication 9, dans lequel le mécanisme d'échange comprend les étapes suivantes :

on calcule un paramètre de bénéfice en performances (SwapBinP) ayant une valeur égale à une différence entre un plus bas de tous les paramètres de qualité de canal normaux, et un plus bas de tous les paramètres de qualité de canal spécifiques à la fonction d'échange;
on envoie une demande d'échange contenant le paramètre de bénéfice en performance (SwapBinP) vers un autre point d'accès qui correspond au plus bas de tous les paramètres de qualité de canal spécifiques à la fonction d'échange de tous les points d'accès répondeurs (AP2);
on attend une réponse d'échange provenant dudit autre point d'accès (AP2);
on commute vers un canal correspondant au plus bas de tous les paramètres de qualité de canal spécifiques à la fonction d'échange, si la réponse d'échange est "oui";
on commute vers un canal correspondant au plus bas de tous les paramètres de qualité de canal normaux si la réponse d'échange est "non".

11. Procédé selon la revendication 8, dans lequel le point d'accès est un point d'accès répondeur d'échange (AP2) le procédé de sélection d'un canal optimal par un point d'accès incluant en outre les étapes suivantes :

on reçoit une demande d'échange provenant d'un point d'accès demandeur d'échange (AP1) fonctionnant sur un premier canal (C1), tandis que le point d'accès répondeur d'échange fonctionne sur un second canal (C2);
on répète la scrutation de tous ses canaux pour collecter des réponses d'investigation provenant d'autres points d'accès;
on commute du second canal (C2) vers le premier canal (C1);
on calcule un paramètre de qualité de canal spécifique à la fonction d'échange (ssCSIQ (C1)) pour le premier canal (C1), ce paramètre de qualité de canal spécifique à la fonction d'échange (ssCSIQ(C1)) étant calculé dans l'hypothèse selon laquelle le point d'accès répondeur (AP2) et le point d'accès demandeur d'échange (AP1) ont déjà échangé des canaux;
on envoie une réponse d'échange "oui" si le paramètre de qualité de canal spécifique à la fonction d'échange (ssCSIQ(C1)) pour le premier canal (C1) est inférieur à un paramètre de qualité de canal normal (regCSIQ(C2)) calculé pour le second canal (C2).

12. Procédé selon la revendication 11, ce procédé comprenant en outre l'accomplissement des étapes suivantes :

on reçoit un paramètre de bénéfice en performances (SwapBinP) du point d'accès demandeur d'échange, ayant une valeur égale à une différence entre un plus bas de tous les paramètres de qualité de canal normaux et un plus

bas de tous les paramètres de qualité de canal spécifiques à la fonction d'échange, pour le point d'accès demandeur d'échange;
si aucune réponse d'échange "oui" ne peut être envoyée, on calcule un paramètre de diminution de performances indiquant une diminution des performances du point d'accès répondeur d'échange qui se produirait lorsqu'il aurait échangé des canaux avec le point d'accès demandeur d'échange;
on envoie une réponse d'échange "oui" si le paramètre de bénéfice en performances (SwapBinP) est plus grand que le paramètre de diminution de performances.

13. Procédé selon l'une quelconque des revendications 8 à 12, dans lequel le point d'accès est arrangé pour utiliser le mécanisme d'échange seulement après qu'un temps prédéterminé s'est écoulé depuis une dernière fois que le mécanisme d'échange a été utilisé.

14. Produit - programme d'ordinateur destiné à être chargé par un point d'accès pour un réseau de communication du type réseau local sans fil, ce produit - programme d'ordinateur procurant au point d'accès la capacité de :

surveiller sa charge de trafic de point d'accès;
envoyer des demandes d'investigation et des réponses d'investigation vers d'autres points d'accès;
recevoir des demandes d'investigation et des réponses d'investigation provenant d'autres points d'accès;
inclure des informations concernant la charge de trafic dans les réponses d'investigation;
calculer et stocker un paramètre de brouillage pour chacun d'une multiplicité de ses canaux possibles ;
calculer et stocker un paramètre de partage de canal pour chacun de la multiplicité de canaux;
calculer un paramètre de qualité de canal normal (regCSIQ) pour chacun de la multiplicité de canaux, indiquant le niveau de brouillage et de partage de canal sur chacun de la multiplicité de canaux, en utilisant les paramètres de brouillage et de partage de canal;
sélectionner de façon dynamique un canal optimal parmi la multiplicité de canaux possibles en utilisant les paramètres de qualité de canal normaux (regCSIQ),

caractérisé en ce que le point d'accès est arrangé pour sélectionner le canal optimal en échangeant mutuellement des canaux avec un autre point d'accès, en utilisant un mécanisme d'échange.

15. Produit - programme d'ordinateur selon la revendication 14, comprenant un porteur de données.

Fig 1a

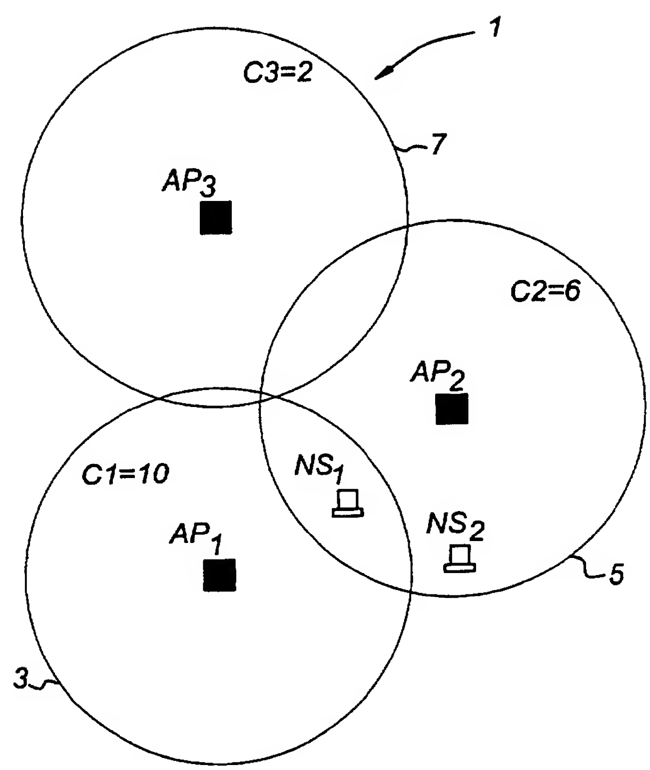


Fig 1b

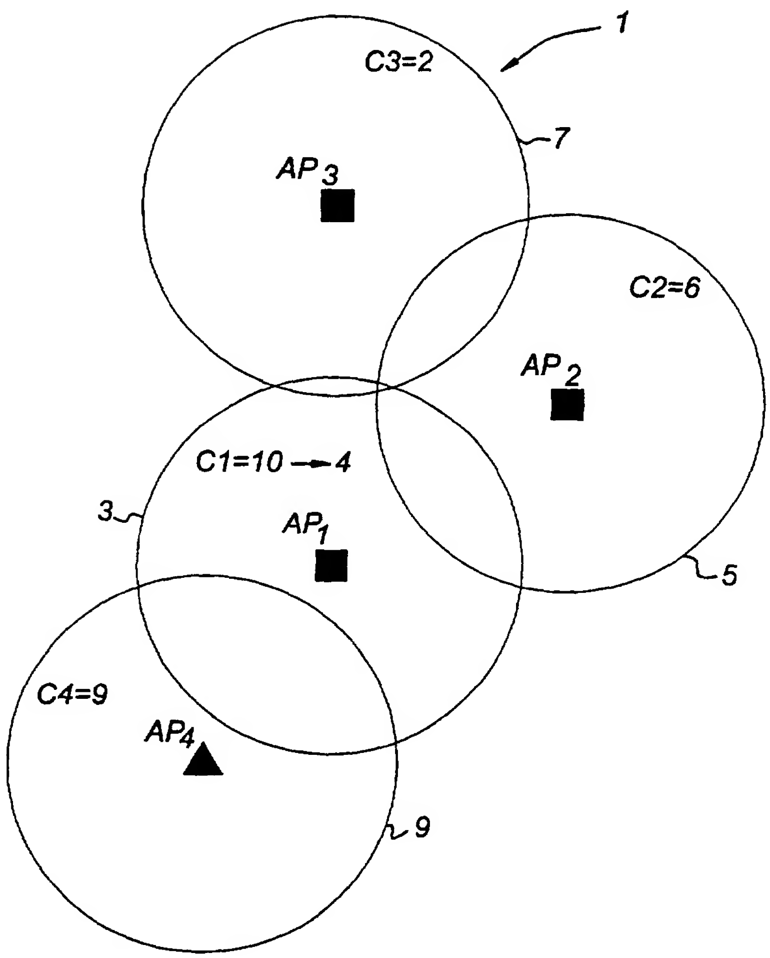


Fig 1c

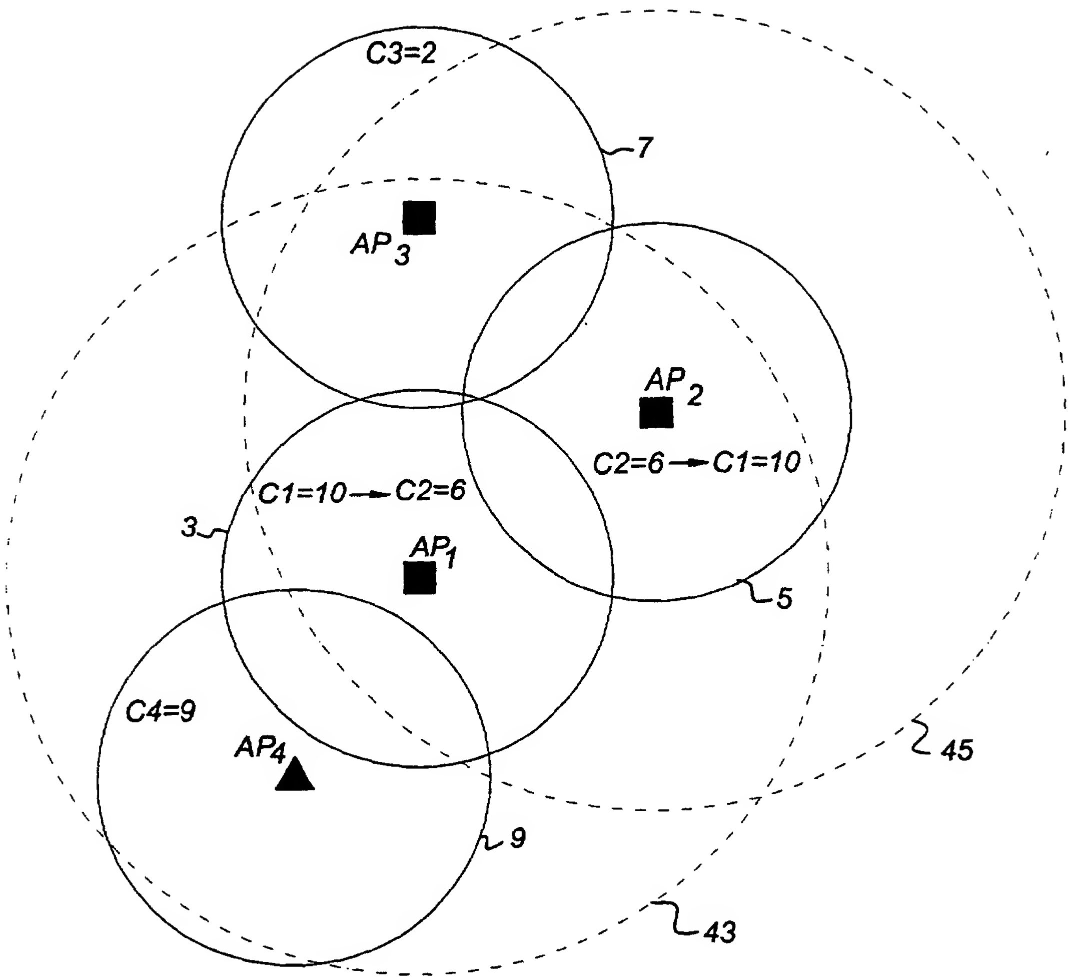


Fig 2

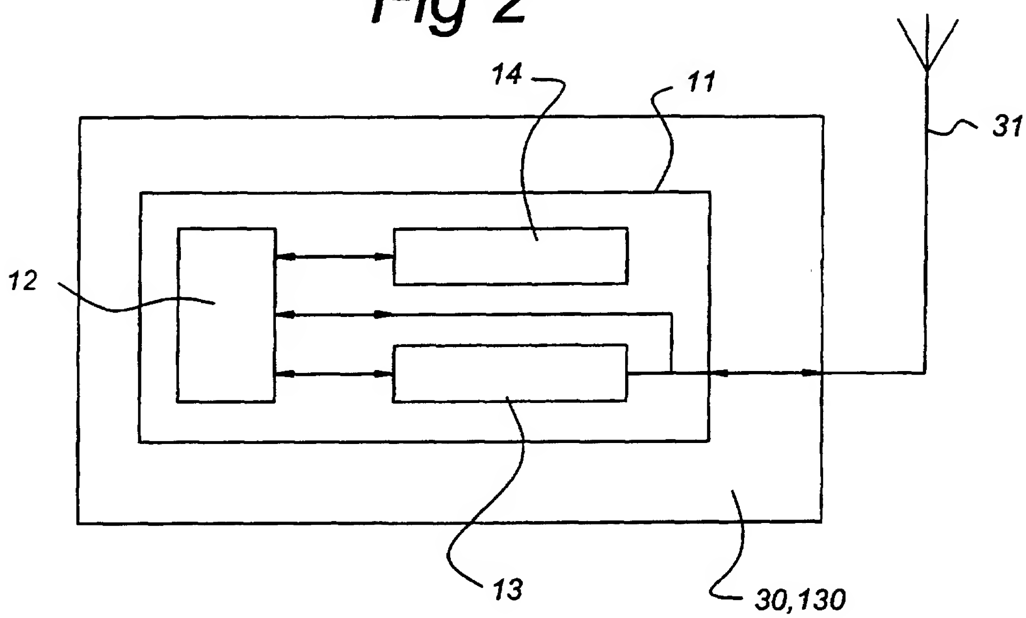


Fig 3

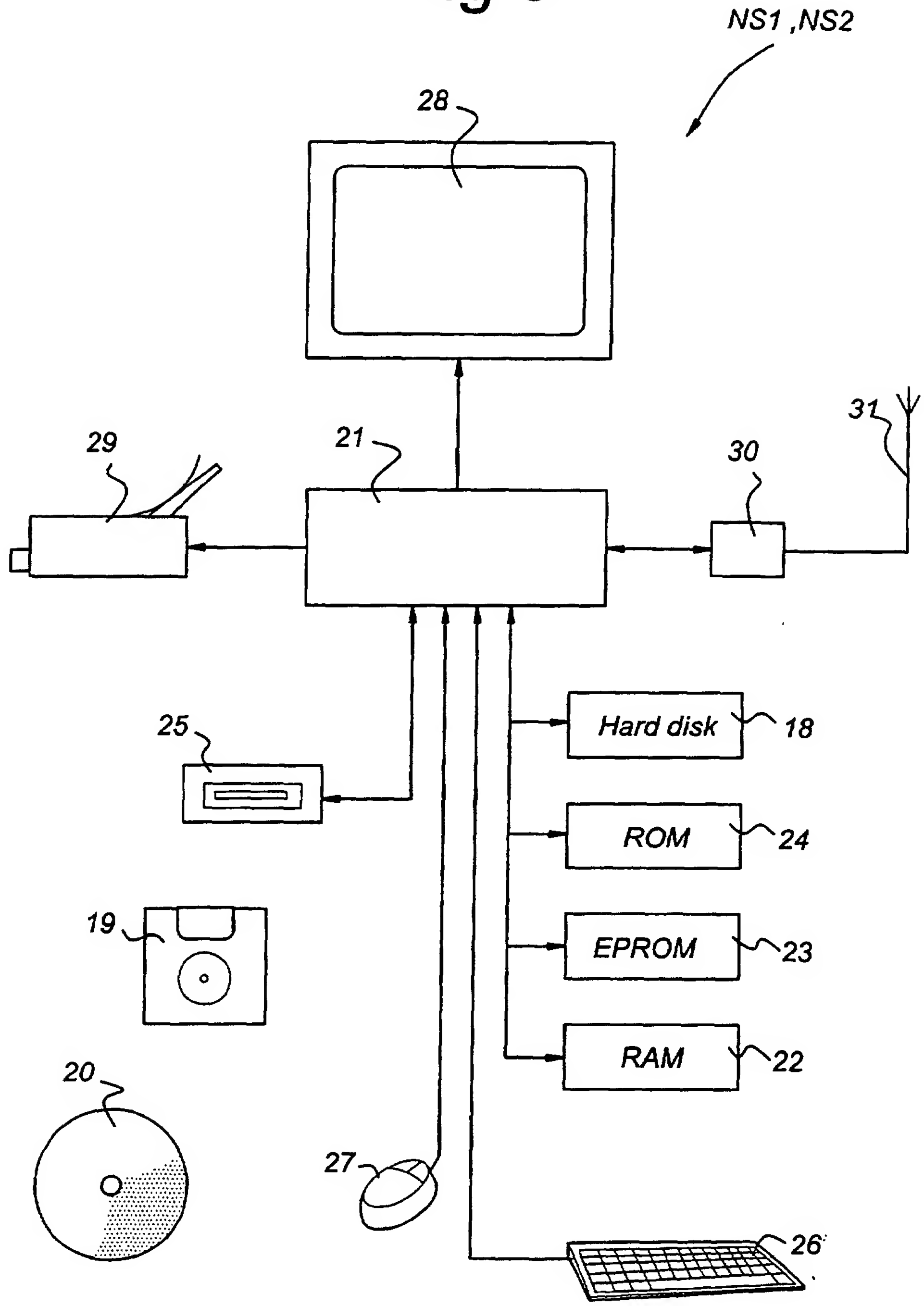
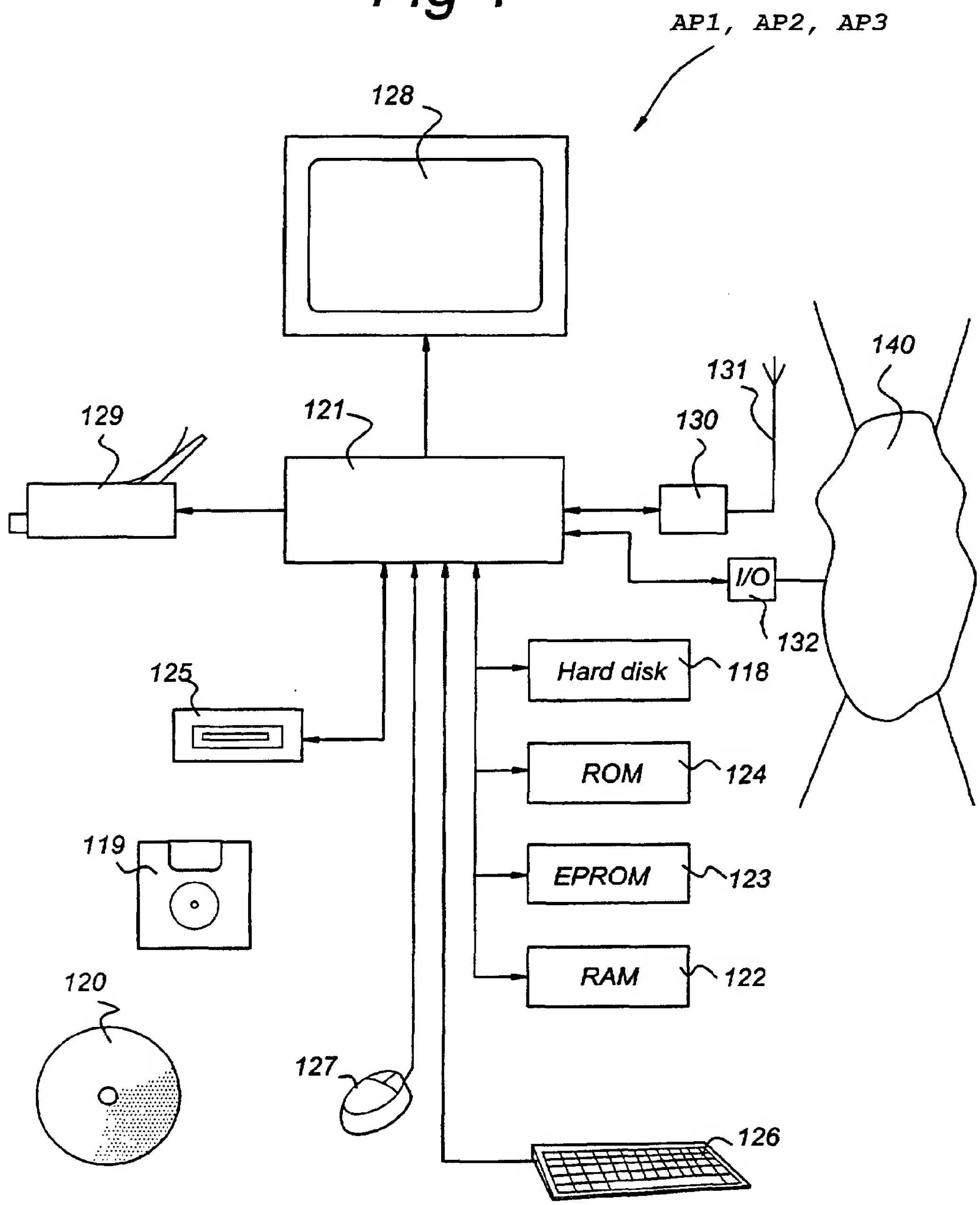

NS1 ,NS2
28
29
21
31
30
25
Hard disk
18
ROM
24
19
EPROM
23
RAM
22
20
27
26

Fig 4


AP1, AP2, AP3
128
140
131
129
121
130
I/O
132
125
Hard disk
118
ROM
124
119
EPROM
123
RAM
122
120
127
126

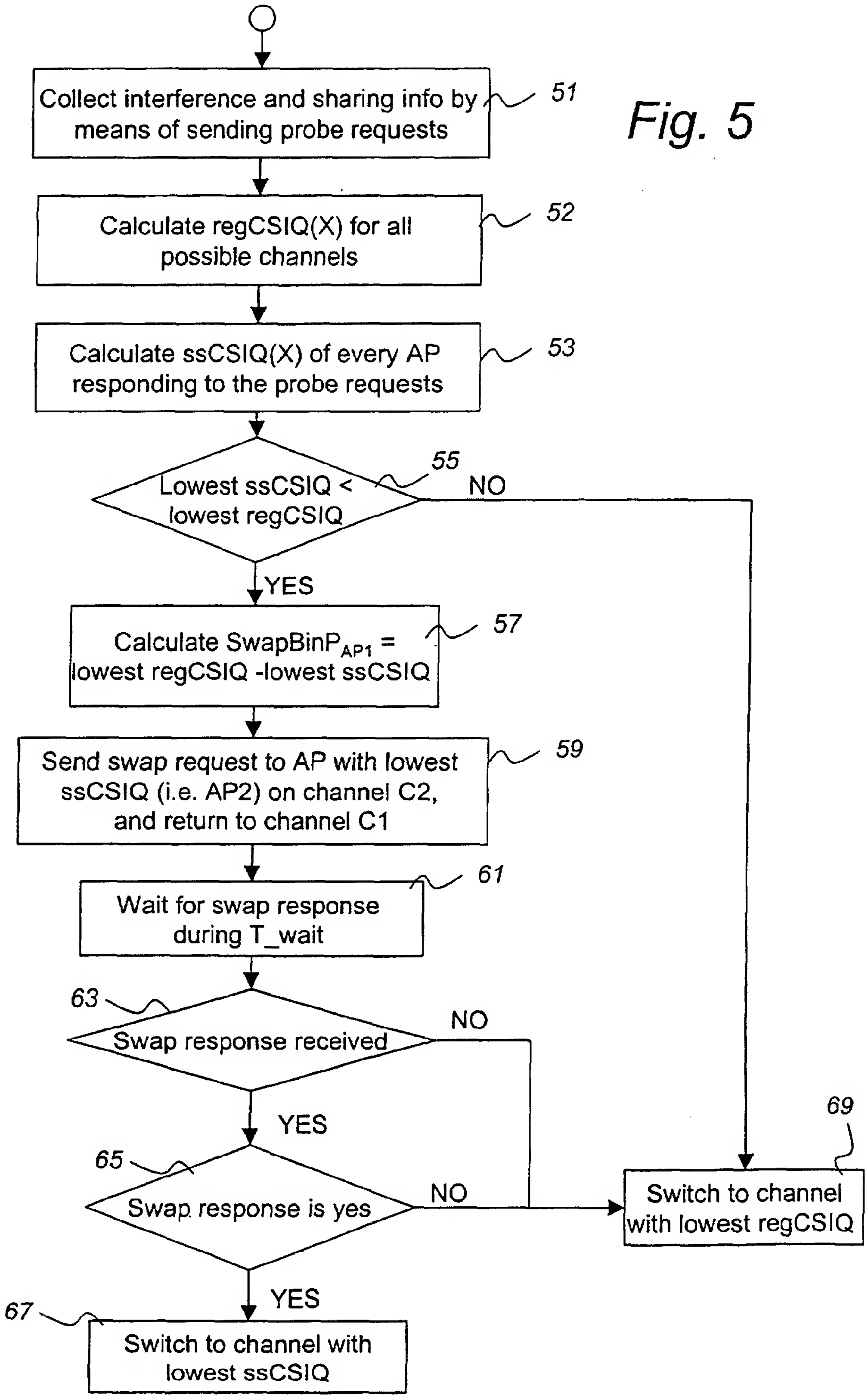

Collect interference and sharing info by means of sending probe requests
51
Calculate regCSIQ(X) for all possible channels
52
Calculate ssCSIQ(X) of every AP responding to the probe requests
53
Lowest ssCSIQ < lowest regCSIQ
55
NO
YES
Calculate SwapBinP$_{AP1}$ = lowest regCSIQ -lowest ssCSIQ
57
Send swap request to AP with lowest ssCSIQ (i.e. AP2) on channel C2, and return to channel C1
59
Wait for swap response during T_wait
61
63
Swap response received
NO
YES
65
Swap response is yes
NO
YES
67
Switch to channel with lowest ssCSIQ
69
Switch to channel with lowest regCSIQ

Fig. 5

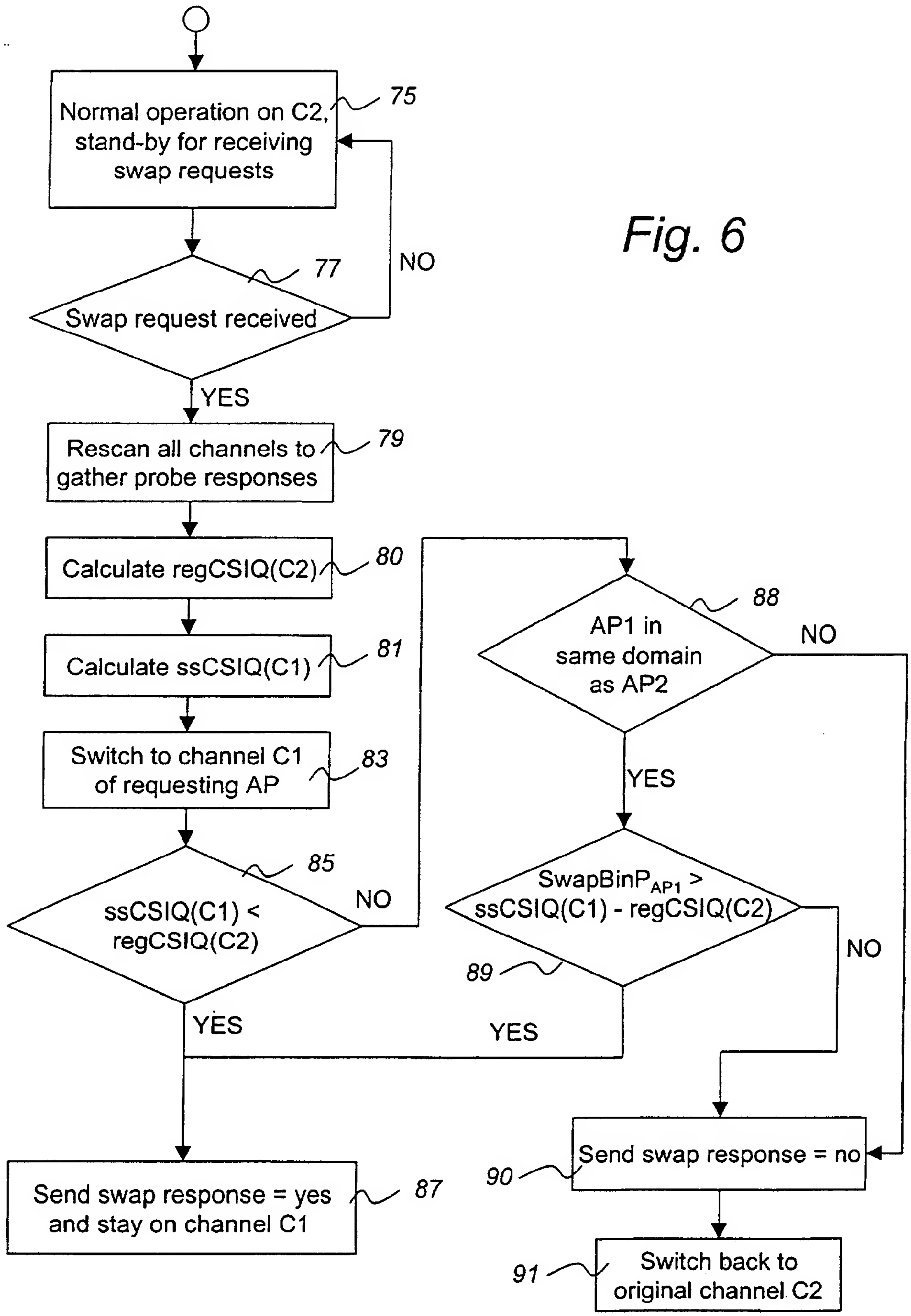

Normal operation on C2, stand-by for receiving swap requests
75
Swap request received
77
NO
YES
Rescan all channels to gather probe responses
79
Calculate regCSIQ(C2)
80
Calculate ssCSIQ(C1)
81
Switch to channel C1 of requesting AP
83
ssCSIQ(C1) < regCSIQ(C2)
85
NO
YES
AP1 in same domain as AP2
88
NO
YES
$SwapBinP_{AP1}$ > ssCSIQ(C1) - regCSIQ(C2)
89
NO
YES
Send swap response = yes and stay on channel C1
87
Send swap response = no
90
Switch back to original channel C2
91

Fig. 6